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EVALUATION OF PULL-OUT TESTING OF EPOXY COATED DOWELS IN CONCRETE USING GROUTS AND EPOXIES

MATERIALS INFORMATION

ENGINEERING MATERIALS OFFICE

EVALUATION OF PULL-OUT TESTING OF EPOXY COATED DOWELS IN CONCRETE USING GROUTS AND EPOXIES

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SUMMARY

Six non-shrink proprietary grouts and five proprietary epoxies were tested for pull-out strength at various embedment lengths. The pull-out test was used to determine the minimum embedment length that would produce a minimum pull-out strength of at least 40 kN.

All eleven products met this requirement at the 125 mm embedment length.

INTRODUCTION

Each year the Ministry of Transportation repairs a number of existing bridges with thin slab decks. The parapet walls and curbs on these structures are often replaced by barrier walls. The barrier walls are anchored to the existing bridge decks with 15 M epoxy coated reinforcing bars spaced at 220 mm. Holes are drilled into the existing bridge decks and a suitable grout or epoxy is used to bond the epoxy coated rebars to the existing concrete. The minimum bridge deck thickness likely to be encountered when installing the new barrier walls is 150 mm. In order to maintain an adequate thickness of concrete beneath the bar, the smallest embedment length is estimated to be 125 mm. A minimum pull-out strength of 40 kN is specified by the Ministry of Transportation, Structural Office. This office requested from the Concrete Section a list of bonding agents that would meet this requirement.

In a preliminary pull-out test program two grout materials and three epoxies were used to bond a 15 mm epoxy coated rebar. The two grouts were tested at two embedment lengths and with two diameters of core drilled holes. The epoxies were tested using hole diameters specified by the manufacturers and at two embedment lengths. It was found that a smaller hole diameter produced the best pull-out strength for one of the grouts. Hole diameter did not influence the pull-out strength of the other grout. By using the smaller diameter hole, more efficient use of the product will be made and a consistent policy can be established. It was also found that two of the epoxies tested required topping up during placing as these products were absorbed into the concrete. Since that time the third material has been replaced by an improved product (Hilti Hit replaced by Hilti C-100 Hit).

MATERIALS TESTED

Six proprietary grouts and five epoxies were tested for pull-out strengths. Table A shows the grouts tested, trade name, the manufacturer and the mix proportions recommended by the manufacturer to produce a pourable mix. Table A-1 shows the epoxies tested, trade name and the manufacturer.

TEST PROCEDURE

Each proprietary grout in Table A was tested for pull-out strength at 125 mm, 190 mm and 250 mm embedment lengths. The epoxies in Table A-1 were tested for pull-out strength at 125 mm and 250 mm embedment lengths, except Hilti C-100 Hit which was tested at 127 mm and 254 mm embedment lengths. Two specimens were tested for each embedment length.

Half a bag of each grout was mixed in a concrete mixer and was of sufficient volume to fabricate all specimens. The mix proportions (dry grout to water) were as shown in Table A. The epoxies were mixed according to the manufacturer's instructions.

For the grout specimens thirty-six unreinforced concrete blocks 300 mm x 300 mm x 300 mm in size and twelve unreinforced concrete blocks 150 mm x 300 mm x 300 mm in size were cast using a standard Ministry of Transportation 30 MPa concrete mix with 80 ± 10 mm slump and 6 ±1% air. The blocks were moist cured for 14 days, then air dried for a minimum of 14 days. A hole 38 mm in diameter

TABLE A GROUTS TESTED

PRODUCT NAME	MANUFACTURER	RECOMMENDED MIX PROPORTIONS WATER : GROUT RATIO
MASTERFLOW 713 GROUT	MASTER BUILDERS CO.	25 kg DRY GROUT TO 5 L WATER 0.200
MASTER BUILDERS SET NON SHRINK GROUT	MASTER BUILDERS CO.	22.7 kg DRY GROUT TO 3.8 L WATER 0.167
SIKA GROUT 212	SIKA CANADA INC.	25 kg DRY GROUT TO 4.15 L WATER 0.166
STERNSON M-BED STANDARD GROUT	STERNSON LTD.	25 kg DRY GROUT TO 5.5 L WATER 0.220
CPD NON-SHRINK GROUT	CONST. PRODUCTS DISTRIBUTION SERVICES	25 kg DRY GROUT TO 4.0 L WATER 0.160
SONOGROUT	SONNEBORN BUILDING PRODUCTS	25 kg DRY GROUT TO 3.3 L WATER 0.132

TABLE A-1 EPOXIES TESTED

PRODUCT NAME	MANUFACTURER
HILTI C100-HIT	HILTI CANADA LTD.
SIKADUR 35 (HI MOD LV)	SIKA CANADA INC.
CAPPAR #3	CAPPAR LTD.
BOLT ANCHOR COMPOUND #906 NON-SAG MORTAR	CONCRETE CHEMICALS
BOLT ANCHOR COMPOUND #902	CONCRETE CHEMICALS

was core drilled into each block. The depth of the hole for each set of twelve concrete blocks 300 mm x 300 mm x 300 mm in size was 125 mm, 190 mm and 250 mm. The depth of the hole for the concrete blocks 150 mm x 300 mm x 300 mm in size was 125 mm. The hole was then washed out with water and wiped with a damp cloth. If grouting could not take place right away the hole was protected from dirt and dust. The hole was pre-dampended for a period of one hour before grouting. A 15 mm (Grade 400) epoxy coated rebar 760 mm long was then grouted into the hole. The grouted specimens were allowed to set at room temperature for a minimum time of six days. A fork lift was used to position each specimen in the testing machine. A steel frame 300 mm x 300 mm x 25 mm frame thickness was placed beneath the concrete block to distribute the load to the perimeter of the block (Figure 1).

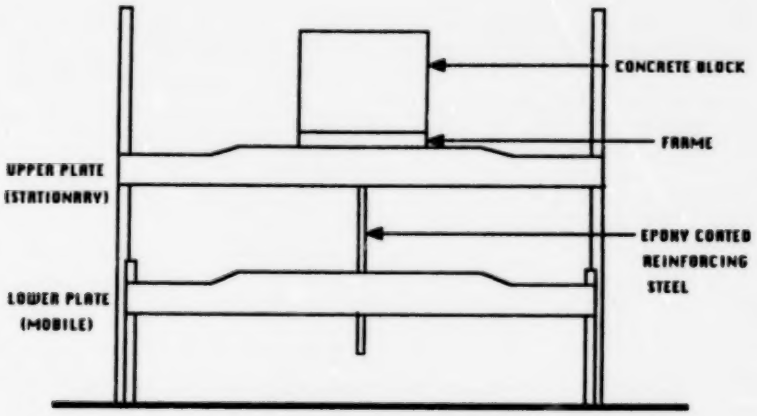

FIGURE 1 PULL-OUT TESTING APPARATUS

The pull-out loads were applied at a rate of approximately 100 kN per minute. Once the maximum load was achieved the anchorage pull-out was allowed to continue to observe the manner of failure.

In the preliminary pull-out test program twelve unreinforced concrete blocks 300 mm x 300 mm x 300 mm in size and twelve 175 mm x 300 mm x 300 mm in size were cast using a standard Ministry of Transportation 30 MPa concrete mix. The blocks were moist cured for seven days, then air dried for twenty-one days minimum. After the blocks cured, the holes were drilled and cleaned.

Eight pull-out tests were performed on each of the two grouts. (CPD Non-Shrink Grout and Sternson M-Bed Standard Grout). The grouts were mixed according to the manufacturer's instructions to produce a pourable mix. The grouts were tested at two embedment lengths (125 mm and 250 mm) and with two diameters of core drilled holes (38 mm and 51 mm).

Four pull-out tests were performed on each epoxy (Sikadur 35 and Cappar #3), two at 125 mm embedment length and two at 250 mm embedment length using the hole diameters specified by the manufacturer. The epoxies were mixed according to the manufacturer's instructions.

The epoxies were inserted into dry holes while the holes for the grouts were dampened. Epoxies were allowed to set for four days and grouts were allowed to set for six days. Testing was carried out in the same manner as for the previous grouts.

Ontario's Hydro Research Division tested Hilti C-100 Hit system for pull-out strength. A 3/4" diameter hole was drilled in two 300 mm x 300 mm x 300 mm and in two 450 mm x 450 mm x 450 mm concrete cubes to a depth of 127 mm and 254 mm respectively. After the holes were cleaned out a 760 mm length of 15 M, Grade 400, epoxy coated rebar was grouted into each cube. The specimens were allowed to cure at room temperature for four days. Each cube was tested for pull-out strength in a universal testing machine. The pull-out loads were applied at a rate of approximately 100 kN per minute. Once the maximum load was achieved, the anchorage pull-out was allowed to continue to observe the manner of failure.

Bolt Anchor Compound #906 Non-Sag Mortar and Bolt Anchor Compound #902 were tested for pull-out strength by M. Nasiruddin and Associates Ltd. Four concrete blocks 175 mm x 300 mm x 300 mm and four concrete blocks 300 mm x 300 mm x 300 mm were cast using a standard Ministry of Transportation 30 MPa air entrained concrete, with a cement content of 355 kg/m3. After 28 days of moist curing, 3/4" diameter by 125 mm deep holes were drilled in the centre of each 175 mm block, and 3/4" diameter by 250 mm deep holes were drilled in the 300 mm blocks. The holes were cleaned by brush and oil free air blast. The epoxy compound was mixed according to the manufacturer's instructions. Epoxy coated steel reinforcing rods 15 mm in diameter (Grade 400) were embedded into the epoxy filled holes and supported to ensure the rod was 90° to the concrete surface. After 7 days of curing in standard laboratory conditions, tensile loads were applied to the reinforcing rods using a steel bridge, calibrated hydraulic jack and gauge set-up.

TEST RESULTS

The results for the six proprietary grouts in Table A are shown in Table B and Table C.

The Structural Office of the Ministry of Transportation of Ontario specifies a minimum pull-out strength of 40 kN for barrier wall dowels. All the grouts tested greatly exceeded this requirement. Table B indicates that Sternson M-Bed Standard Grout at the 125 mm and 190 mm embedment length had the lowest pull-out strengths (73.0 kN, 99.7 kN) while CPD Non-Shrink Grout had the highest pull-out strengths (89.5 kN, 122.4 kN). At the 250 mm embedment length the pull-out strengths varied from 118.6 kN with Masterflow 713 Grout to 142.2 kN with Master Builders Set Non-Shrink Grout. Table C shows that the pull-out strengths at the 125 mm embedment length using the 150 mm x 300 mm x 300 mm concrete blocks are lower for each grout than that produced by the 300 mm x 300 mm x 300 mm concrete blocks. Nevertheless the pull-out strength for each grout is well above the minimum requirement of 40 kN. The pull-out strengths vary from 59.4 kN for Master Builers Set Non-Shrink Grout to 69.2 kN for Masterflow 713 Grout. Block failure may have influenced the failure load of the grouts. The grouts would probably have failed at a higher load had the concrete blocks been reinforced.

TABLE 8 PULL-OUT RESULTS (NON-SHRINK GROUT)

PRODUCT	HOLE DEPTH (mm)	LOAD FAILURE (kN)	AVE.	OBSERVATIONS AFTER TEST	COMMENTS
MASTERFLOW 713 GROUT	125	79.7		BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE	
	125	78.5	79.1	BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE,CONCRETE BLOCK CRACKED	
	190	133.1		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	190	94.3	113.7	BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE,CONCRETE BLOCK CRACKED	
	250	124.6		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	112.6	118.6	CONCRETE BLOCK SPLIT INTO TWO PIECES	
MASTER BUILDERS SET NON-SHRINK GROUT	125	79.7		BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE,CONCRETE BLOCK CRACKED	SETS UP VERY QUICKLY
	125	80.1	79.9	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	190	89.5		BOND FAILURE OF GROUT TO CONCRETE,CONCRETE BLOCK CRACKED	
	190	143.3	116.4	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	165.5		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	116.8	142.2	CONCRETE BLOCK SPLIT INTO TWO PIECES	
SIKA GROUT 212	125	78.3		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	125	78.8	78.6	CONC. BLOCK SPLIT HORIZONTALLY BELOW THE HOLE,UPPER PORTION OF CONC. BLOCK SPLIT INTO FOUR PIECES	
	190	101.5		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	190	114.8	108.2	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	135.3		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	117.5	126.4	CONCRETE BLOCK SPLIT INTO TWO PIECES	
STERNSON M-BED STANDARD GROUT	125	73.4		BOND FAILURE OF GROUT TO CONCRETE	
	125	72.5	73.0	BOND FAILURE OF GROUT TO CONCRETE,CONCRETE BLOCK CRACKED	
	190	101.0		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	190	98.4	99.7	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	141.1		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	129.1	135.1	CONCRETE BLOCK SPLIT INTO TWO PIECES	
CPD NON-SHRINK GROUT	125	89.5		BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE	
	125	89.5	89.5	BOND FAILURE OF GROUT TO CONCRETE,SPALLING ON THE SURFACE,CONCRETE BLOCK CRACKED	
	190	108.6		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	190	136.2	122.4	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	166.9		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	112.6	139.8	CONCRETE BLOCK SPLIT INTO TWO PIECES	
SONOGROUT	125	82.8		CONC. BLOCK SPLIT HORIZONTALLY BELOW THE HOLE,UPPER PORTION OF CONC. BLOCK SPLIT INTO FOUR PIECES	
	125	85.7	84.3	CONC. BLOCK SPLIT HORIZONTALLY BELOW THE HOLE,UPPER PORTION OF CONC. BLOCK SPLIT INTO FOUR PIECES	
	190	122.8		CONC. BLOCK SPLIT HORIZONTALLY BELOW THE HOLE,UPPER PORTION OF CONC. BLOCK SPLIT INTO THREE PIECES	
	190	106.4	114.6	CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	128.6		CONCRETE BLOCK SPLIT INTO TWO PIECES	
	250	120.6	124.6	CONCRETE BLOCK SPLIT INTO THREE PIECES	

CONCRETE BLOCK SIZE 300mm*300mm*300mm

HOLE DIA.= 38 mm

TABLE C PULL-OUT RESULTS (NON-SHRINK GROUT)

PRODUCT	HOLE DIA. (mm)	HOLE DEPTH (mm)	CONCRETE BLOCK SIZE (mm mm mm)	LOAD FAILURE (kN)	AVE.	OBSERVATIONS AFTER TEST
MASTERFLOW 713 GROUT	38	125	150*300*300	68.1		CONCRETE BLOCK SPLIT INTO TWO PIECES,SPALLING ON THE SURFACE
	38	125	150*300*300	70.3	69.2	CONCRETE BLOCK SPLIT INTO THREE PIECES
MASTER BUILDERS SET NON-SHRINK GROUT	38	125	150*300*300	60.7		CONCRETE BLOCK SPLIT INTO THREE PIECES
	38	125	150*300*300	58.1	59.4	CONCRETE BLOCK SPLIT INTO TWO PIECES
SIKA GROUT 212	38	125	150*300*300	66.3		CONCRETE BLOCK SPLIT INTO TWO PIECES
	38	125	150*300*300	53.2	59.7	CONCRETE BLOCK SPLIT INTO TWO PIECES,SPALLING ON THE SURFACE
STERNSON M-BED STANDARD GROUT	38	125	150*300*300	63.4		CONCRETE BLOCK SPLIT INTO TWO PIECES,SPALLING ON THE SURFACE
	38	125	150*300*300	62.8	63.1	CONCRETE BLOCK SPLIT INTO TWO PIECES,SPALLING ON THE SURFACE
CPD NON-SHRINK GROUT	38	125	150*300*300	60.1		CONCRETE BLOCK SPLIT INTO TWO PIECES
	38	125	150*300*300	60.7	60.4	CONCRETE BLOCK SPLIT INTO TWO PIECES
SONOGROUT	38	125	150*300*300	57.2		CONCRETE BLOCK SPLIT INTO TWO PIECES
	38	125	150*300*300	68.1	62.6	CONCRETE BLOCK SPLIT INTO TWO PIECES

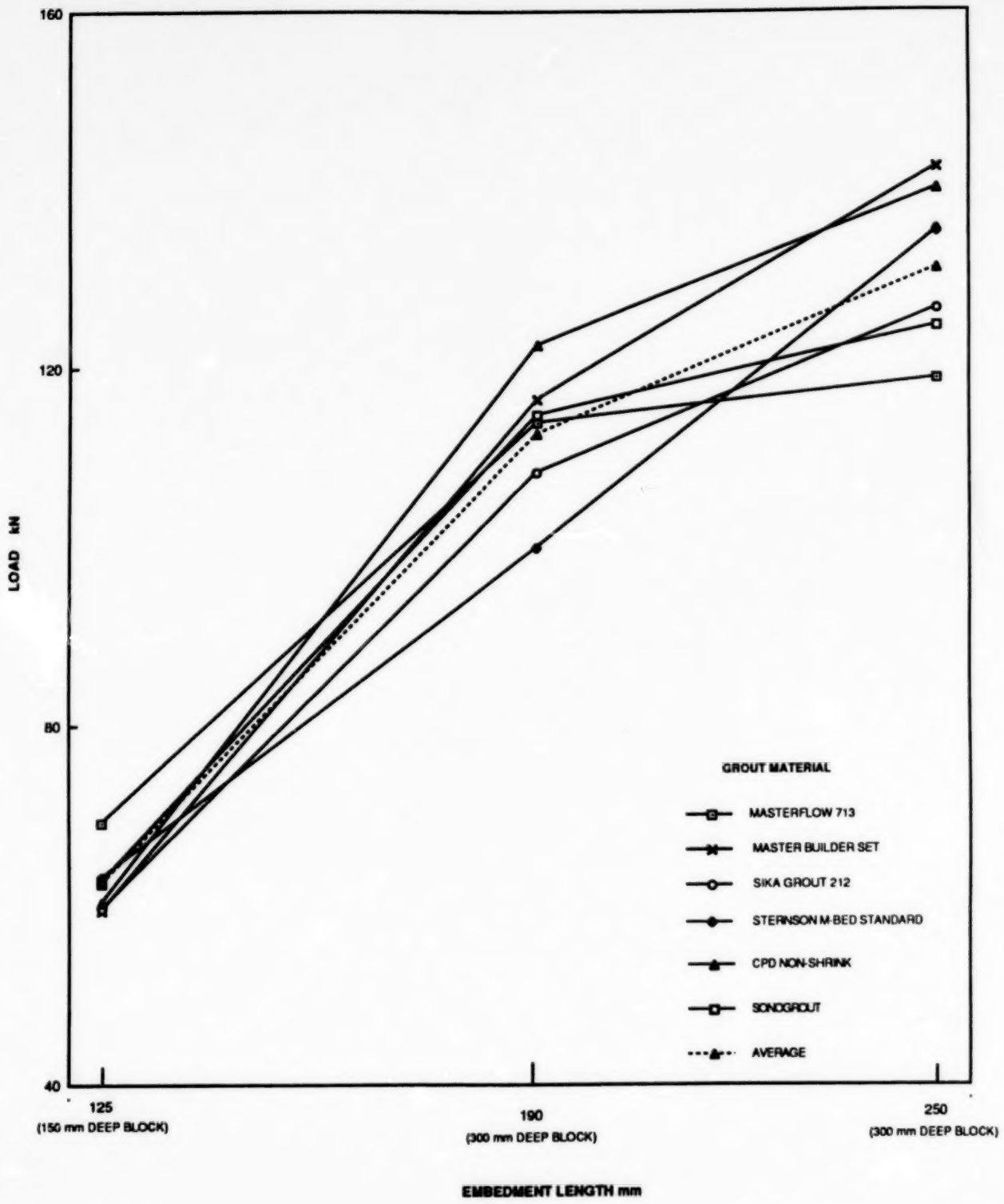

FIGURE 2 LOAD VERSUS EMBEDMENT LENGTH

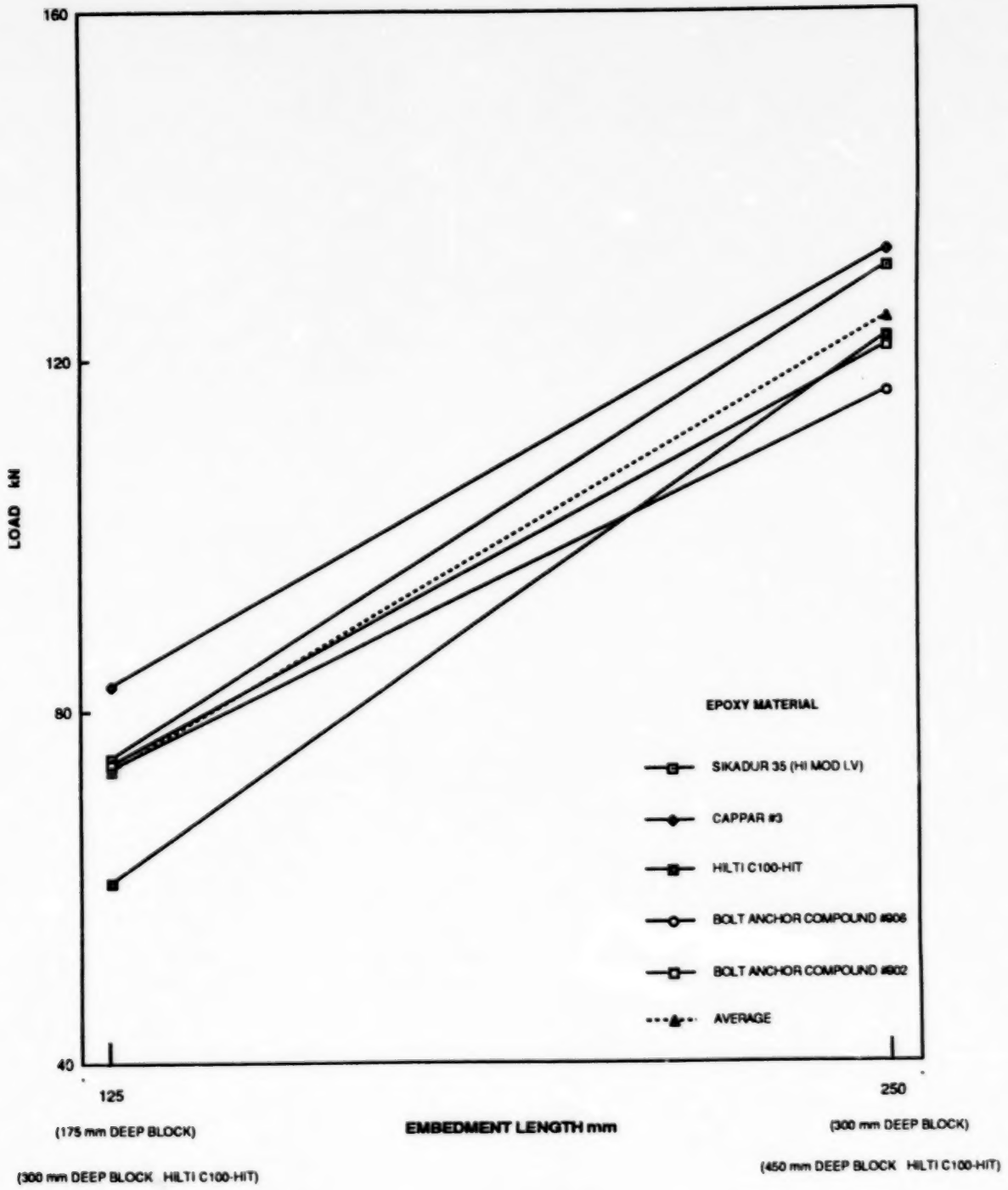

FIGURE 3 LOAD VERSUS EMBEDMENT LENGTH

TABLE D **PULL-OUT RESULTS (NON-SHRINK GROUT)**

PRODUCT	HOLE DIA. (mm)	HOLE DEPTH (mm)	CONCRETE BLOCK SIZE (mm mm mm)	LOAD FAILURE (kN)	AVE.	POINT OF FAILURE
CPD NON-SHRINK GROUT	38	125	175*300*300	39.4		GROUT TO CONCRETE (UPPER PORTION OF BAR),BAR TO GROUT FACE (LOWER PORTION OF BAR)
	38	125		57.4	48.4	BAR TO GROUT FACE
	51	125	175*300*300	22.2		GROUT TO CONCRETE
	51	125		18.0	20.1	GROUT TO CONCRETE
	38	250	300*300*300	158.8		GROUT TO CONCRETE (UPPER PORTION OF BAR),BAR TO GROUT FACE (LOWER PORTION OF BAR),BLOCK SPLIT
	38	250		142.3	150.6	BAR TO GROUT FACE,BLOCK SPLIT
	51	250	300*300*300	121.9		GROUT TO CONCRETE
	51	250		128.3	125.1	GROUT TO CONCRETE (UPPER PORTION OF BAR),BAR TO GROUT FACE (LOWER PORTION OF BAR),BLOCK SPLIT
STERNSON M-BED STANDARD GROUT	38	125	175*300*300	20.5		GROUT TO CONCRETE FACE
	38	125		16.7	18.6	GROUT TO CONCRETE FACE (UPPER PORTION OF BAR),BAR TO GROUT(LOWER PORTION OF BAR)
	51	125	175*300*300	22.4		GROUT TO CONCRETE FACE
	51	125		19.2	20.8	GROUT TO CONCRETE FACE
	38	250	300*300*300	122.3		GROUT TO CONCRETE FACE
	38	250		94.7	108.5	BAR TO GROUT, BLOCK SPLIT
	51	250	300*300*300	124.5		BAR TO GROUT, BLOCK SPLIT
	51	250		97.4	111.0	GROUT TO CONCRETE FACE
***	38	250	300*300*300	163.8		BAR TO GROUT

*** SPECIMEN SUBJECTED TO 50 FREEZE THAW CYCLES

Figures 2 and 3 provide graphs of strength versus embedment length for the grout and epoxy materials. Average strength line is also included in the graphs.

Table D summarizes the pull-out strength results on CPD Non-Shrink Grout and Sternson M-Bed Standard Grout. At the 125 mm embedment length CPD Non-Shrink Grout achieved greater pull-out strength with the smaller of the hole diameters tested. The smaller diameter hole met the required pull-out strength requirement while the bigger hole diameter did not. Hole diameter did not influence the pull-out strength of Sternson M-Bed Standard Grout. In both cases the required pull-out strengt was not achieved. At the 250 mm embedment length actual pull-out strengths greatly exceeded those required. Sternson M-Bed Standard Grout specimen exposed to 50 freeze-thaw cycles achieved a pull-out strength of 163.8 kN. Old grout material used in the 125 mm embedment length test could have contributed to the low pull-out loads.

Table E presents the pull-out strength results of epoxies. In all cases the pull-out strengths exceed the minimum required pull-out strength of 40 kN. At the 125 mm embedment length the pull-out strength varied from 60.5 kN with Hilti-Hit C-100 to 82.7 kN with Cappar #3. At the 250 mm embedment length the pull-out strength varied from 116.3 kN with Bolt Anchor Compound #906 Non-Sag Mortar to 132.5 kN with Cappar #3. The pull-out strength of Cappar #3 specimen subjected to 50 freeze-thaw cycles was 146.4 kN.

The pull-out strength of the freeze-thaw specimens for both bonding agents was not affected by the freeze-thaw conditions. The freeze-thaw specimens were ponded with 3% sodium chloride solution. Each cycle consists of 16 - 18 hours in a freezing environment followed by storage at 23 ± 2°C for 6 - 8 hours.

CONCLUSION

All the proprietary grouts and epoxies tested satisfy the pull-out requirement of 40 kN at the 125 mm embedment length for barrier wall dowels.

RECOMMENDATIONS

1. A core drilled 38 mm diameter hole and a minimum embedment length of 125 mm be used with the approved proprietary grouts.

2. A hole diameter recommended by the manufacturer as shown in Table E and a minimum embedment length of 125 mm be used with the approved epoxies.

3. Holes for non-shrink grout must be pre-dampened for a period of one hour with no free water and holes for epoxy must be dry prior to the application of the anchoring agent.

4. Small batches only must be used with Master Builders Set Non-Shrink Grout.

5. If the epoxies shrink during use, the hole must be topped up prior to placing barrier wall concrete.

6. Both the epoxies tested and the approved non-shrink grouts can provide an ultimate pull-out strength of 55 kN if the previous recommendations are followed. However, the actual pull-out strength achieved in the field will be affected by the cleanliness of the hole, the dampness of the hole, the mixing and proportioning of the anchoring material, the curing of the anchoring material, the shelf life of the anchoring material and the strength of the existing concrete.

TABLE E PULL-OUT RESULTS (EPOXY)

PRODUCT	HOLE DIA. (mm)	HOLE DEPTH (mm)	CONCRETE BLOCK SIZE (mm mm mm)	LOAD FAILURE (kN)	AVE.	OBSERVATIONS AFTER TEST
SIKADUR 35 (HI MOD LV)	25	125	175*300*300	74.5		BOND FAILURE OF BAR TO EPOXY,BLOCK SPLIT
	25	125		74.5	74.5	BOND FAILURE OF BAR TO EPOXY,BLOCK SPLIT
	25	250	300*300*300	128.8		BOND FAILURE OF BAR TO EPOXY,(UPPER PORTION OF BAR),EPOXY TO CONCRETE (LOWER PORTION OF BAR),BLOCK SPLIT
	25	250		132.5	130.7	BOND FAILURE OF EPOXY TO CONCRETE,BLOCK SPLIT
CAPPAR #3	25	125	175*300*300	88.7		CONCRETE WAS SHEARED NEAR EPOXY/CONCRETE FACE,BLOCK SPLIT
	25	125		76.7	82.7	CONCRETE WAS SHEARED NEAR EPOXY/CONCRETE FACE,BLOCK SPLIT
	25	250	300*300*300	129.9		BOND FAILURE OF BAR TO EPOXY,(UPPER PORTION OF BAR),EPOXY TO CONCRETE (LOWER PORTION OF BAR),BLOCK SPLIT
	25	250		135.0	132.5	BOND FAILURE OF BAR TO EPOXY,(UPPER PORTION OF BAR),EPOXY TO CONCRETE (LOWER PORTION OF BAR),BLOCK SPLIT
***	25	250	300*300*300	146.4		BOND FAILURE OF EPOXY TO CONCRETE,BLOCK SPLIT
HILTI C100-HIT (•)	19	127	300*300*300	59.9		BOND FAILURE WITH SMALL CONCRETE SPALL AT THE SURFACE
	19	127		61.0	60.5	BOND AND CONCRETE BLOCK FAILURE
	19	254	450*450*450	135.7		BOND FAILURE
	19	254		109.5	122.6	BOND FAILURE
BOLT ANCHOR COMPOUND #906 NON-SAG MORTAR (•)	19 (3/4")	125	175*300*300	75.6		CONCRETE BLOCK SPLIT INTO TWO PIECES,EPOXY BONDED TO BAR AND CONCRETE
	19 (3/4")	125		71.2	73.4	CONCRETE BLOCK SPLIT INTO TWO PIECES,EPOXY BONDED TO BAR AND CONCRETE
	19 (3/4")	250	300*300*300	117.0		CONCRETE BLOCK FAILED,EPOXY BONDED TO BAR AND CONCRETE
	19 (3/4")	250		115.6	116.3	CONCRETE BLOCK FAILED,CONE SHAPED PORTION OF CONCRETE BONDED TO EPOXY AND BAR
BOLT ANCHOR COMPOUND #902 (•)	19 (3/4")	125	175*300*300	72.1		CONCRETE BLOCK SPLIT INTO TWO PIECES,EPOXY BONDED TO BAR AND CONCRETE
	19 (3/4")	125		75.3	73.7	CONCRETE BLOCK SPLIT INTO THREE PIECES,EPOXY BONDED TO BAR AND CONCRETE
	19 (3/4")	250	300*300*300	122.8		REINFORCING BAR FAILED IN TENSION ABOVE BLOCK
	19 (3/4")	250		120.1	121.5	CONCRETE BLOCK FAILED,EPOXY BONDED TO BAR AND CONCRETE

(•) TESTED BY INDEPENDENT LABORATORIES
*** SPECIMEN SUBJECTED TO 50 FREEZE THAW CYCLES